





A Facial Expression Based Continuous Emotional State Monitoring System with GPU Acceleration

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Introduction & motivation

- Continuous emotional state monitoring system from facial expression
 - Recognize emotions continuously in naturalistic 2D facial expression videos
 - Dimensional emotional space
 - Activation
 - Valence
 - Frame level detection/recognition
 - Real value labels
 - Regression problem instead of classification problem
 - Real-time implementation

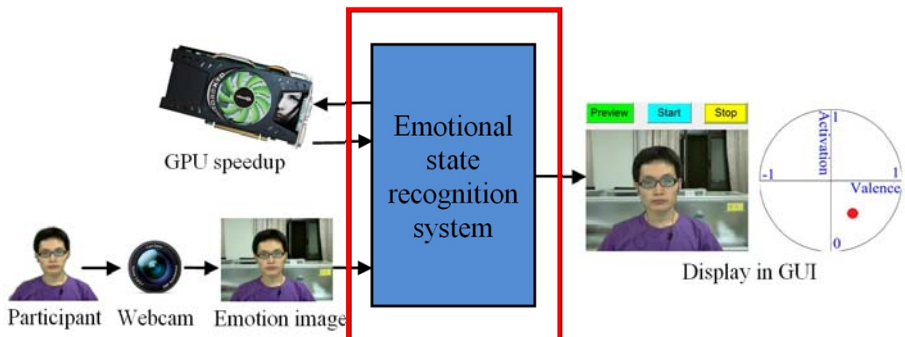
Introduction & motivation

- Possible applications
 - With the ability of real-time emotion detection, machines such as robots, toys and game consoles can interact with users according to users' emotional states.
- Very few emotional state recognition systems have been put into daily practice (real-time) due to computing complexity.
- GPUs are rising as a powerful parallel computing platform to accelerate general purpose applications
- Supported by Royal Society of Engineering in UK
- Initial results are reported in this paper






Overview

- Basic structure of the system





The diagram illustrates the basic structure of the system. It shows a flow from a **Participant** through a **Webcam** to an **Emotion image**, which is processed by the **Emotional state recognition system**. This system is supported by **GPU speedup**. The output is displayed in a **GUI**, which includes a video feed of the participant and a circular plot showing **Activation** and **Valence** levels. The plot has a red dot in the lower-right quadrant, indicating a specific emotional state. The GUI also features **Preview**, **Start**, and **Stop** buttons.






Data collection

- Record videos(5 participants,10 videos, 10frames/s)

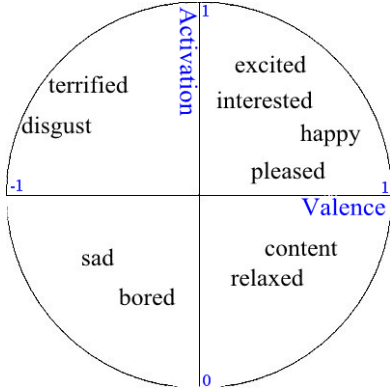








Annotation

- Labelling (2 raters)
- Gtrace tool
- Activation-Valence




Absolutely no urge to be active

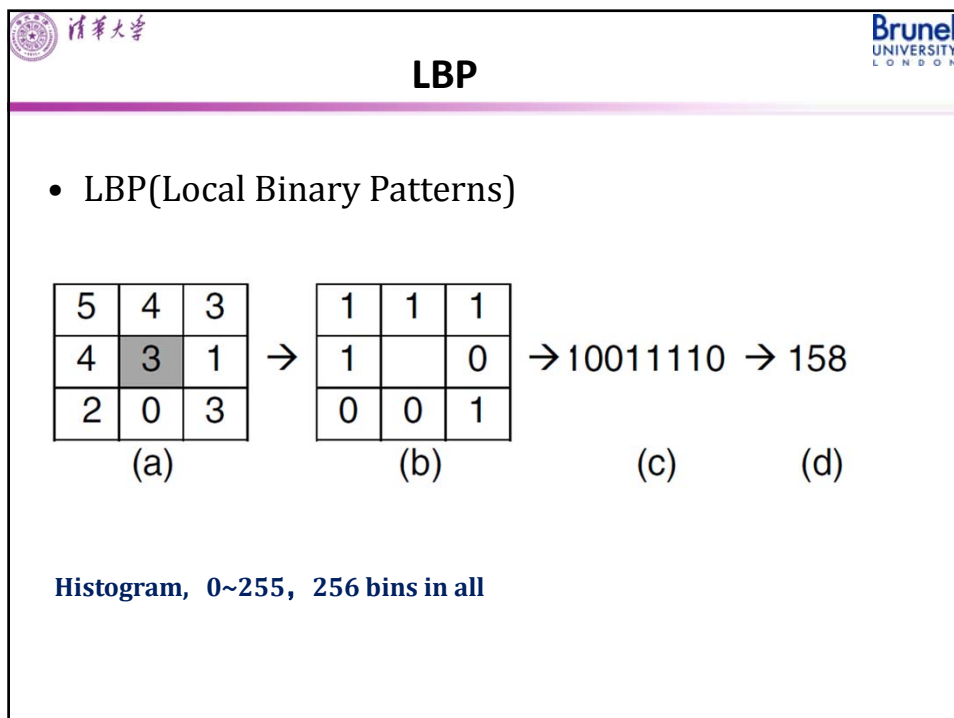
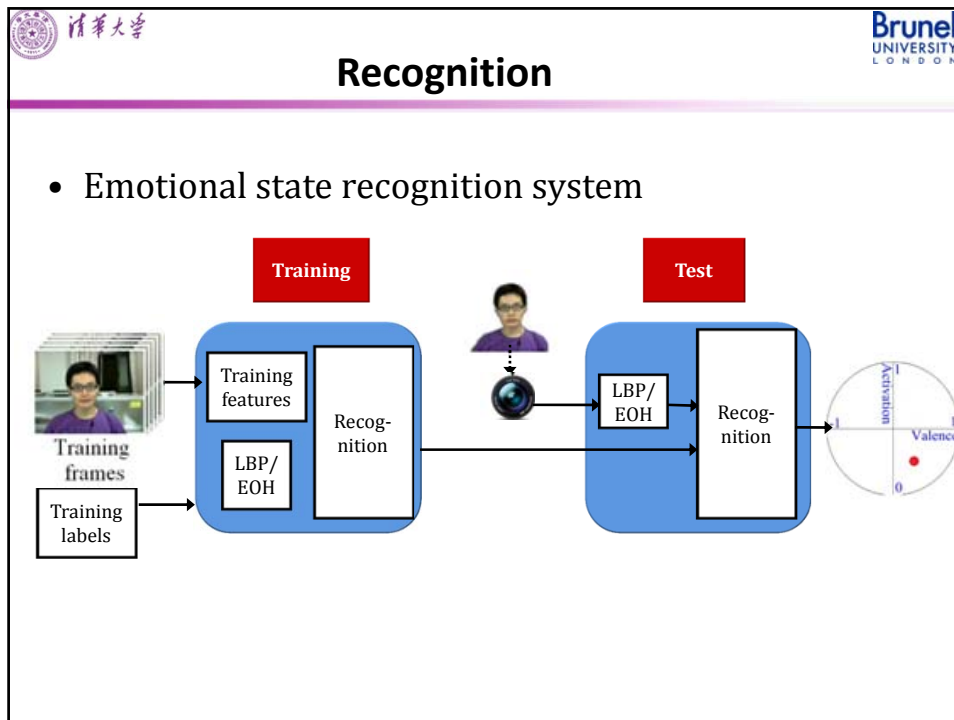




Compelling urge to be active

Very strongly negative





Very strongly positive



Programming

- Co-Programming between Matlab and CUDA C
 - Matlab provides the Mex-file to invoke CUDA code on GPU and handle the CPU-GPU data transfer.
 - 1) *Memory allocation on the GPU.*
 - 2) *Data movement from the host memory to the GPU Global memory.*
 - 3) *Execution of CUDA code on GPU.*
 - 4) *Data movement from the GPU to host.*
 - 5) *Clean-up of the memory allocated on the GPU.*

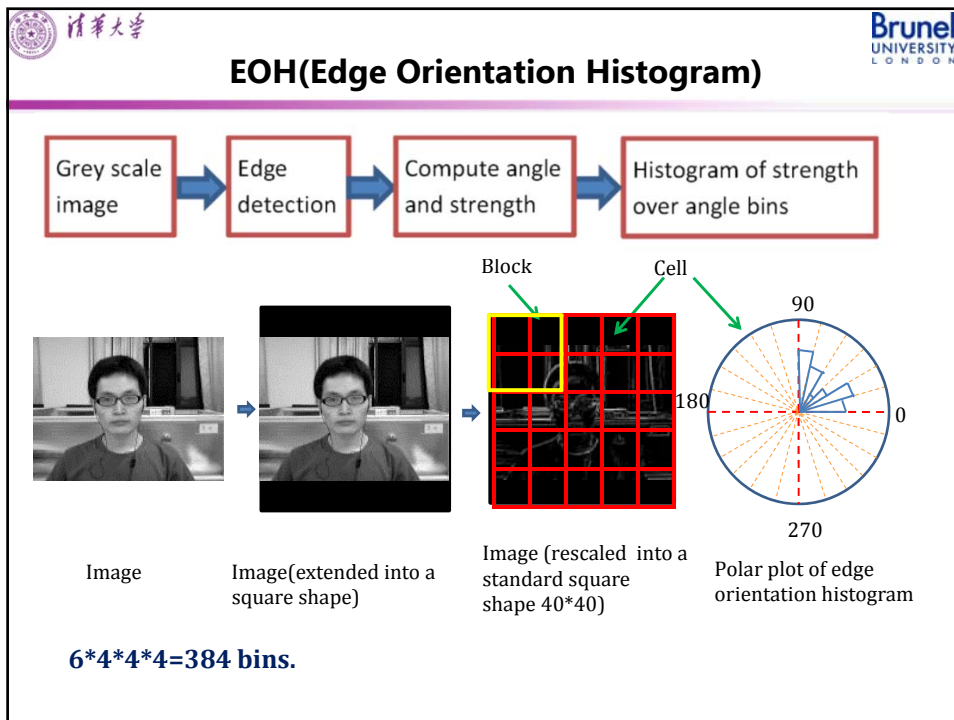
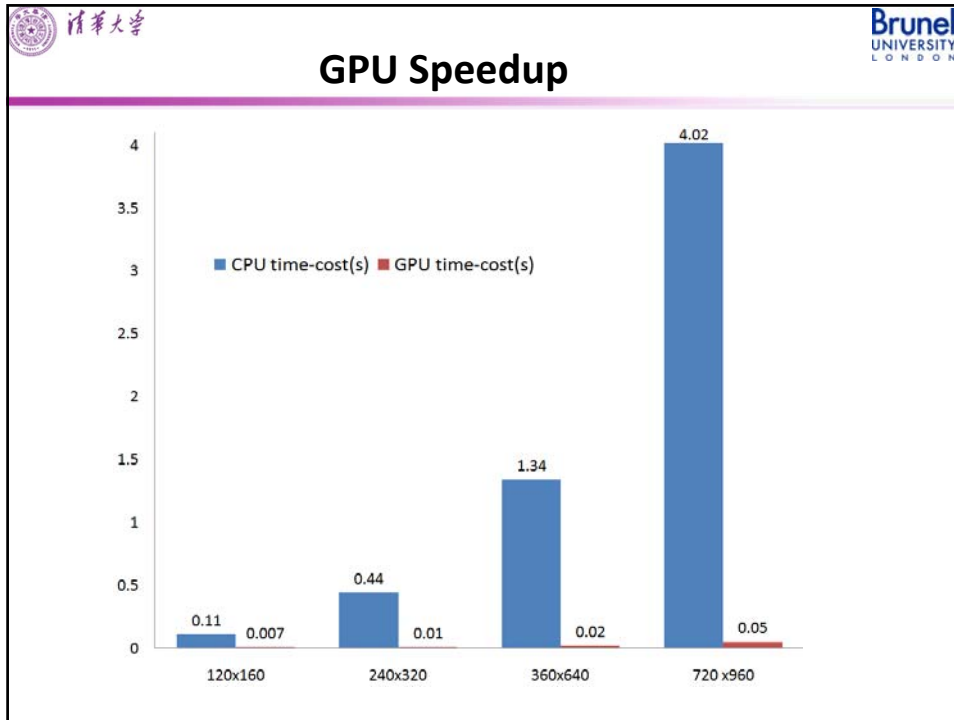
Speedup



- LBP(Local Binary Patterns)

Resolution	<i>CPU(s)</i>	<i>GPU(s)</i>	<i>Speedup</i>
RGB_120x160	0.11	0.007	16X
RGB_240x320	0.44	0.01	44X
RGB_360x640	1.34	0.02	67X
RGB_720 x960	4.02	0.05	80X

```

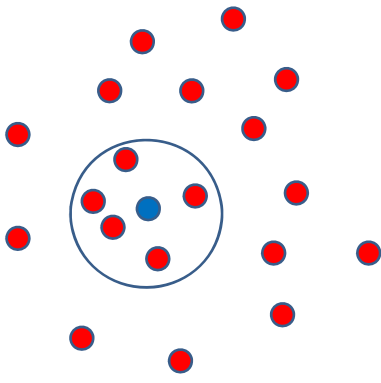
#define DIMX 120
#define DIMY 160
#define threadx 12
#define thready 16
dim3 threads(threadx,thready);
dim3 blocks(DIMX/threadx,DIMY/thready);
```





Regression

- K-NN(K-Nearest Neighbours)
 - K=5



Average the label values of its K nearest neighbours in the training dataset (red).

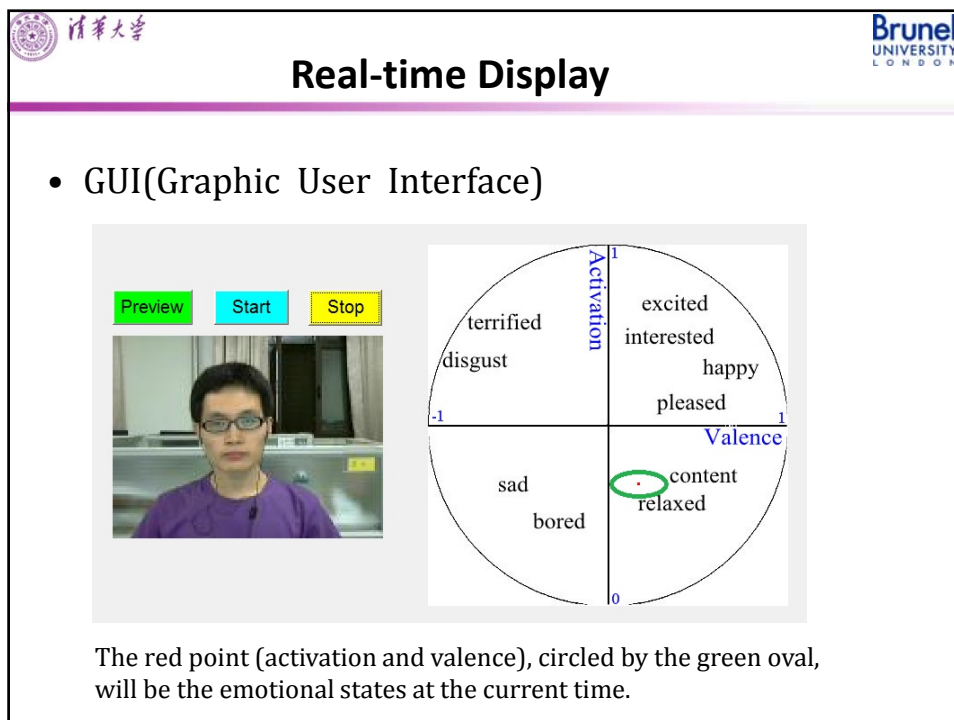
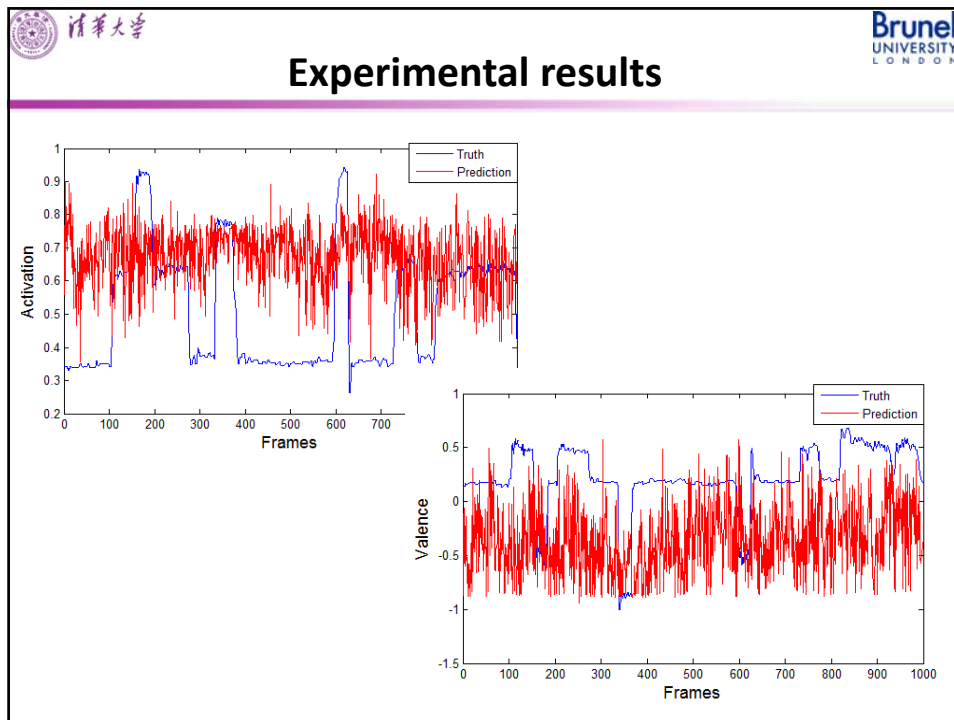
label	feature
0.345	449 336 37 90 ...
0.345	464 333 41 79 ...
...	...
0.337	452 346 26 82 ...
...	...
-0.563	438 323 41 85 ...
....	...






Evaluation

- Correlation Coefficients on two-folds cross evaluation



<i>Features</i>	First fold		Second fold		Average	
	<i>Activation</i>	<i>Valence</i>	<i>Activation</i>	<i>Valence</i>	<i>Activation</i>	<i>Valence</i>
LBP	0.258	0.147	0.139	0.069	0.199	0.108
EOH	0.277	0.164	0.243	0.352	0.260	0.258





Conclusion and Discussion

- Conclusion
 - The initial system can work in real-time with GPU acceleration
 - It is a reference design (framework/platform)
- Possible improvements
 - System can be implemented in C++
 - Other features can be added
 - Different feature extraction implementation can be done
 - More regression methods can be implemented



Thanks

Q&A time~